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THE SHENANDOAH VALLEY: WHY IT IS WHERE IT IS

SHENANDOAH Valley—"daughter of the stars"—is renowned for its scenic beauty, eventful history, spectacular caverns, unique Natural Bridge, and excellent farms and orchards. Those who live in the Valley or travel often through it take most of these features for granted without either wonder or curiosity as to their origins. Many visitors come and go, and they too admire the scenery and the products of the soils, and take them for granted—as they often do natural features. Some are impressed by the awe-inspiring natural wonders and become inquisitive about them. Only a few, however, stop to ask Why? and How? and When?

Many observers or readers no doubt would be surprised at the statements that at one time there was neither Shnandoah Valley nor Blue Ridge; that at one time the whole region was an indistinguishable part of a vast plain sloping gently toward the Atlantic; that still earlier the Valley region was occupied by great mountain ridges; and that in still more remote times it was at the bottom of a huge shallow mediterranean basin that was many times inundated by waters from the Atlantic, Arctic, and Gulf seas. Strange as it may seem, those are facts, recorded indubitably as "current events" of past geologic cycles.

A reviewer once aptly stated, "Science as well as fiction has its mysteries, clues, and detectives." Shenandoah Valley had many geologic mysteries—all long unsolved, some still to be solved. The detectives are the geologists and engineers, either professional or amateur, who have studied the natural features of the Valley and other regions in the search for scientific truths or to make some contribution toward the conservation and development of age-old mineral resources and water supplies. The clues are numerous, but like all clues that lead to the deciphering of mysteries, one must understand how to recognize them and how to interpret them when they are discovered.

About 140 years ago it was first recognized in a scientific sense that ordinary processes working at and near the surface of the earth accomplish certain definite far-reaching results. It was soon deduced that these processes had acted in the same manner, producing similar results, throughout geologic eras; for example, the first rains that ran vigorously down slopes eroded rocks and soils just as they do now under similar conditions; or, as waves beat upon coasts in times of storm and tear down the weaker rocks, so, since time immemorial, have lands disappeared gradually into the seas. Thus it has been axiomatic for decades that geologic agents and processes have always operated in ways similar to those we can now observe.

All landscapes have been sculptured and modeled by geologic processes. Hills, valleys and plains have inscribed in their features records of the processes and the agents that fashioned them out of the rocks of the earth's crust. Each landscape, like the floor of Shenandoah Valley, resembles a tapestry of interwoven patterns of ancient events. The patterns and the details of the physiognomies of all topographic features are full of significance to trained interpreters.

Each layer of rock in the Valley is literally a manuscript of contemporary earth history. In it is recorded something of the nature of the lands from which the sediment was derived, the agent of transportation, the distance of travel, and the environment in which the material was deposited. Some rocks give clues also as to the contemporary climates. The fossils—remains of ancient plants and animals—in many beds give indications of the floras and faunas of those times. More than that, they generally suggest whether the sediment accumulated on land, in lakes, or in seas. They afford reliable clues also to trace out the extent of ancient inland seas and their connections with the principal oceans or with seas that inundated other lands. For example, limestone beds in the Valley contain fossil marine shells that are found also in similar rocks in the Arctic and Baltic regions.

To complete our investigation of data bearing on the origin of Shenandoah Valley, we should note briefly certain observable geologic features. The rocks of the Valley are virtually all sedimentary, that is, they were once particles of sediment derived directly or indirectly from older rocks. They are now chiefly sandstones, shales, and limestones, that is, cemented and solidified beds of sand, mud, and limy mud or ooze. Surficial deposits of boulders, gravel, and sand are found in many areas, particularly not far from the larger streams. Peculiar masses of limy materials have been deposited in some stream beds and in the large caverns. In a few places, bodies of dark-colored crystalline rocks are found. These are masses of molten rock that were forced upward into overlying rocks where they cooled and solidified.

Casual observation shows that the stratified rocks of the Valley are not horizontal—the position in which the sediments were deposited—but are tilted at gentle to steep angles. Closer examination shows that the beds generally have definite trends to the northeast and the southwest, roughly parallel to the Blue Ridge. In some stream gorges and road cuts, complete folds, arches, or downwarps, can be seen.

The topographic features of the Valley at first appear quite diversified, but they can be readily catalogued. Observation from some high point, as the Skyline Drive, shows that the Valley has a broad undulatory floor, almost a plain. The most prominent feature rising above this general level is Massanutten Mountain. Here and there low ridges or rounded hills also rise above the Valley floor. Close inspection shows that the present drainage is well below the genral plain, that the floor itself has been carved into a series of ravines and broad valleys with intervening broad flattish uplands a few hundred feet above the major streams. Bordering Shenandoah Valley are two prominent mountain ridges, the Blue Ridge on the east and North Mountain on the west. From an elevated observation point it will be noted that the crests of these two ridges and that of Massanutten Mountain have many points at approximately the same altitude. On parts of the adjoining Blue Ridge, broad flats—such as Big Meadows—are present.

Shenandoah Valley has specific characteristics that more or less distinguish it from other geographic units, either in Virginia or in the Appalachian province. They include its general form, topography, altitude, drainage, size, and location. Its caverns and Natural Bridge are in some respects unlike those that occur elsewhere. The rocks, mineral resources, soils, and water supplies, while by no means unique, are nonetheless distinctly characteristic. All of these individualistic features are the result of the geologic history of the region, the present end-products of geologic processes operating through incomprehensible millenia. Even the climate and the vegetation are to some extent products of that chain of events. Human activities and history also, so far as affected by environment, no doubt have been different in the Valley than they would have been if the sequence of major geologic events had been different or if the geologic and topographic features, such as mediterranean seas, high mountains, or a vast coastal plain, were those of some former geologic era.

From the evidence recorded in the rocks and the landscapes of the region, the sequence of events in the geologic panoramas of Shenandoah Valley can be sketched in broad outlines. Many details remain to be determined by intensive studies.

The first panorama that we may envision is that of a broad piedmont plain extending from uplands in what is now Tidewater Virginia westward far into the interior of the continent. The records are so meager and so obscured by subsequent events and the time elapsed since then so long—some hundreds of millions of years—that we can never know much about the characteristics of that ancient land. Earth historians generally think of the region as having a mild to temperate climate and as being devoid of vegetation, unless of the most primitive types.

During the Paleozoic era—the time of "ancient life"—the panorama changes. Relatively shallow mediterranean seas very slowly invaded an elongate trough that was slowly sinking in respect to sea level. This trough extended at times from the Gulf of Mexico area northeastward across the site of the Valley of Virginia and the Blue Ridge via the St. Lawrence basin into the Atlantic Ocean. From epoch to epoch it was some scores to a few hundred of miles wide. Some seas overspread all of Virginia west of the Piedmont province and some invaded parts of the Piedmont region at least as far east as the eastern parts of Buckingham and Prince William counties. During some geologic epochs there were seaways that connected the seas in Virginia with the Arctic Ocean and during others, with the Pacific Ocean. Many times the seas withdrew from the Appalachian trough, leaving the site of the Valley a low land area.

During much of the Paleozoic era Tidewater Virginia and the continent far to the east were occupied by uplands, perhaps at times mountainous. From these uplands streams carried gravel, sand and mud into the western sea, until huge deposits of sediment had accumulated in the sinking trough. As the particles were cemented and compressed together, the present conglomerates, sandstones and shales of the Valley and adjacent mountains were formed. Some of the sandstones no doubt represent old sea beaches and some of the shales suggest extensive mud flats. At one time the southern part of a huge delta spread over the northern part of the Valley area.

During many epochs of the Paleozoic era the marine waters were rather clear. In consequence, huge deposits of limy mud and ooze accumulated, formed in part by chemical and biochemical processes in the seas and in part from the shell debris of countless hordes of shellfish that lived in those seas. Thus we find in Shenandoah Valley thick limestones alternating with sandstones and shales. In the latter part of the era extensive swamps lay over the area now in the western parts of Augusta and Rockingham counties. The vegetation in those swamps accumulated and decayed through millenia to produce ultimately the beds of coal now found between North and Shenandoah mountains. Those coals probably were formed also in at least the western part of the Valley, but if so, they have been eroded away.

These inferences about the scenes in the Paleozoic panoramas are based upon the characteristics of the rocks in Shenandoah Valley and its environs, their distribution, and the entombed fossil invertebrates and plants as well as upon the application of axiomatic principles of geologic interpretation.

The thickness of the sediments that accumulated in the trough in the Shenandoah Valley region has an important bearing upon the subsequent history of the Valley and its present location and characteristics. That thickness, as now measurable across the exposed edges of the tilted rocks, is enormous. Including the strata exposed in the North and Shenandoah mountain area, which formerly without much doubt extended also into the Valley, the total thickness is at least 20,000 feet and may be as much as eight miles. As the younger Paleozoic formations have been entirely eroded from the region, the original total thickness of the formations in the Valley was even greater. These enormous deposits suggest not only the depositional processes and the time involved but also the magnitude of the lands that wasted away in eastern Virginia and elsewhere to produce the sediments.

Toward the close of the Paleozoic era the appearance of the Valley region and of the entire Appalachian province slowly changed. The thick pile of sediments was steadily crushed from the southeast so that the strata rose in billowy folds, crumpled much like sheets of cardboard into a series of great arches and intervening downwarps. It was as though this sector of the earth's crust were squeezed by a huge irresistible piston against the resistant interior mass of the continent. In some zones the lateral pressure was so intense and long-continued that the rocks were stretched beyond their elastic limits; hence they broke along great linear fractures, or faults, and thick blocks or slices were shoved for miles to the northwest. These folds in general had a northeast trend, to which the present trend of Shenandoah Valley corresponds.

This profound deformation, consisting of folding and faulting and marked elevation of the area, was the second type of geologic event that was directly responsible for the location of Shenandoah Valley and some of its specific characteristics. It produced the ancestral Appalachian Mountains, of which only the "roots" remain today.

As the uplifted rocks were vulnerable to the agents of erosion, the newly formed mountains began to disintegrate piecemeal. Gravel, sand, and mud were carried to distant seas by flooded rivers of those times. The wearing away of the Appalachian Mountains was a very slow process, possibly on the average not more than a foot in several thousand years. Eventually, however, the great folds were worn low and bevelled so that the Valley region was part of an extensive plain, part of which sloped gently toward the Atlantic. A few hills of more resistant rocks, such as Stony Man and Hawksbill in the Blue Ridge, rose above the general level. The major streams of that time probably meandered widely over the low plain. A few, like the Potomac, rose far toward the west and flowed toward the Atlantic, whereas others, like New River, rose toward the east and flowed westward. The reduction of the ancestral Appalachian Mountains to the widespread plain was the third great event—the chief event of the Mesozoic era—so far as the ancestry of Shenandoah Valley is concerned.

The fourth great event was a series of gradual vertical uplifts and gentle warpings of the region, in the latter part of the Mesozoic and the early part of the Cenozoic eras. As the erosive powers of the sluggish streams were renewed, they began to cut their channels down toward the level of the sea. It should be noted that they were flowing across more or less parallel belts of resistant and weak rocks. The greatest erosion was obviously on the weaker rocks, such as the limestones and shales that underlie Shenandoah Valley. The more resistant rocks, such as the sandstones, were eroded less rapidly; hence they cap and have held up prominent ridges like Massanutten and North mountains. Resistant crystalline rocks have helped to maintain the altitude of the Blue Ridge above the Valley.

Flattish remnants of the ancient extensive plain that bevelled the folded and faulted rocks are found in some places, as at Big Meadows along the Skyline Drive. The more or less uniform altitudes of the crests of the linear mountain ridges west of Shenandoah Valley suggest also the truncation of the great folds in the ancestral Appalachian Mountains.

After the early Cenozoic erosion of the limestone and shale belts had developed the broad undulatory floor of Shenandoah Valley, there was again gentle vertical uplift. The streams were rejuvenated and began cutting downward. As the larger ones had been meandering across the broad erosional plain—the floor of the Valley—they entrenched their winding courses by this downward cutting, thus perpetuating such features as the "horseshoe bends" in the two branches of Shenandoah River. This latest downward cutting is apparently still in progress.

Numerous secondary features of considerable interest have been developed during the more recent cycles of uplift and erosion. Low hills and ridges that rise above the genral level of the Valley floor are capped by more resistant rock which has locally retarded erosion while the surrounding weaker rocks were worn away. The undulatory floor of the Valley is in part due to solution by ground water, giving rise to abundant sinks and numerous caverns. Natural Bridge has been developed by extensive subterranean erosion along a narrow zone with subsequent collapse of the greater part of the roof of the underground channel.

The location of Shenandoah Valley is thus due to a definite succession of geologic events. The principal groups of events in the long panorama have been (1) the deposition of a thick mass of sedimentary rocks of diverse hardness in the great trough that occupied the Valley region; (2) the deformation of these rocks into a great series of elongate sub-parallel folds that were uplifted far above sea level; (3) the erosion of those ancestral mountains to a widespread plain; (4) the uplift of this plain with the consequent excavation of the Valley on the weaker rocks, whereas the resistant rocks have maintained the mountain ridges; and (5) recent uplift of this lower less extensive Valley-floor plain and its dissection into the present subordinate features.

ARTHUR BEVAN

THE HIGH SCHOOL AS A PEOPLE'S COLLEGE

PART THREE—WHAT SHOULD THE HIGH SCHOOLS TEACH?

IN two preceding articles of this series we have considered the children who go to our high schools, and what children should learn at school. The question which sets the problem for this article must be answered in terms of the other two main considerations: children themselves, and what they should learn if education is to make sense. Children must be taught as they are, in terms of their previous learning experiences, their present interests, their varying abilities to learn; their learning must be directed by wise and sympathetic teachers as interpreter-guides toward the ends which people want to work out in the lives of the children. Just as surely, the schools must teach the things which children should do in order to become a desirable next generation of citizens. To set up any other task for the schools would be foolish, misdirected extravagance.

In attempting to say what should be taught in the high schools we shall not lose sight of the basic factors which go to make secondary education. In this country it has been decided definitely through a long series of developments that high schools are popular institutions supported by all the people to serve all children of appropriate age. Even now, over sixty out of every hundred children eligible to attend high schools do go for a part of each year, and the attendance steadily grows. We also know that among these children the ranges of ability to learn, as well as life interests and character traits, vary as widely as their background of home life and family inheritances. Starting with children who compose such a cross-section of the population, using their interests and such purposes to learn as they are able to draw upon, the schools must work out in these young Americans the ends which are set as the